



Fragmented Governance of International Rivers: Negotiating Bilateral versus Multilateral Treaties¹

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Despite warnings of interstate conflict over shared water resources, states are reaching hundreds of treaties and agreements over their international rivers. We have extensive knowledge about the negotiations process of individual treaties, but there is a paucity of systematic analysis of the forces influencing treaty formation. In addition, the few quantitative studies examining the formation of agreements fail to consider the different factors influencing the rise of bilateral versus multilateral agreements on multilateral basins. Correcting this omission is important because scholars have discovered that states frequently sign bilateral agreements over multilateral rivers, which contradicts the integrated river basin management approach advocated by environmentalists, engineers, and water experts. This study seeks to fill this vacuum within the existing literature by distinguishing between the formation of bilateral treaties on bilateral and multilateral basins and comparing these bilateral forms of cooperation to the formation of multilateral treaties on multilateral basins. Through quantitative analysis, we argue that treaty type is a by-product of state interest, transaction costs, and distribution of power.

Although experts have been warning of the increasing potential for conflict over international rivers, states have been reaching hundreds of agreements to regulate their use of freshwater resources (Wolf 2002). An examination of these agreements reveals that the majority cover multilateral basins (shared by three or more states), even though 67% of the world's 263 international rivers are bilateral (shared by two states) (Wolf 1998). To govern multilateral basins, states have tended to select bilateral treaties rather than multilateral treaties (Song and Whittington 2004). Consequently, the conventional wisdom that has evolved is that negotiations are more likely to take place over multilateral rather than bilateral basins and that the by-product of these talks is more likely to be bilateral rather than multilateral treaties (Conca, Wu, and Mei 2006). However, we still

¹ We thank Ariel Dinar, Mark Giordano, Paul Hensel, Cliff Morgan, Cameron Thies, and Jaroslav Tir for helpful comments. Replication data can be found online at <http://www.saramitchell.org/research.html>.

lack an understanding of what accounts for these fragmented attempts at cooperation over international rivers, such as the Jordan, Euphrates, Indus, and Ganges.

This empirical puzzle reflects a broader issue in the international relations literature, namely the paucity of knowledge about specific forms of cooperation, such as the choice of a bilateral treaty relative to a multilateral treaty, in comparison with the binary choice of cooperation or conflict (Yarbrough and Yarbrough 1992). Rationalist models typically predict bilateral cooperation to be easier to achieve and maintain than multilateral cooperation (Axelrod and Keohane 1985; Oye 1985). Yet, experts have argued that states may choose multilateral treaties if the transaction costs involved in negotiating several bilateral treaties are significant or if a hegemon is willing to pay the sunk cost of negotiating and enforcing cooperation (Martin 1992; Pahre 1994). The extant literature also remains uncertain as to whether these various forms of cooperation are substitutes or complements; bilateral agreements could undermine multilateral cooperation efforts or they could strengthen cooperation in multilateral regimes (Odell 2000; Verdier 2008).

This study seeks to understand the conditions influencing the rise of treaties between riparian states by comparing three contexts for cooperation: (i) bilateral treaties on bilateral basins; (ii) bilateral treaties on multilateral basins; and (iii) multilateral treaties on multilateral basins. Previous empirical studies have tended to lump together all river treaties or to look only at specific forms of cooperation, such as bilateral treaties (Espey and Towfique 2004; Song and Whittington 2004). With very few exceptions (Rixen and Rohlfing 2007; Verdier 2008), the international relations literature also tends to examine multilateral cooperation separately from bilateral cooperation (Denemark and Hoffmann 2008). We believe it is necessary to place more attention on the form of cooperation by delineating the conditions that are favorable to the formation of bilateral and multilateral treaties.

We argue that the combination of state interest, transaction costs, and the distribution of power can explain the likelihood of cooperation in the three separate environments under examination. Our data analysis includes all pairs of states sharing a river from 1816 to 2007, capturing the onset of a new river treaty in each basin dyad-year. We show that heightened water dependence increases the chances for cooperative river treaties in all contexts. Our analysis also shows that transaction costs are significant hurdles to cooperation, especially in the multilateral river context. We also find that the relative distribution of power for upstream and downstream states has differential effects in bilateral and multilateral cooperation contexts. Stark power advantages for upstream states translate into bilateral agreements more frequently, while power parity promotes the emergence of multilateral treaties.

We begin by discussing some of the advantages and disadvantages of fragmented governance. This is followed by a brief literature review of existing work on riparian cooperation through treaty formation. We then develop our theoretical framework focusing on state interest, transaction costs, and the distribution of power. After describing our research design, we present our empirical analyses and we discuss the contributions of our findings to the international relations literature. We conclude with the implications of our findings for the management of freshwater resources.

The Consequences of Fragmented Governance

International rivers contain 60% of our planet's freshwater supplies, cross the territory of some 145 nations, and provide 40% of the world's population with a home along their banks (Wolf 2002). Industrialization and population growth

have increased the demand on a fixed supply of freshwater throughout the world, prompting warnings of future conflicts over shared rivers (Biswas 2008). Climate change, with its anticipated decrease in freshwater supplies and increase in the occurrence of floods and droughts, is projected to aggravate the potential for interstate conflict over freshwater in the Middle East and North Africa (IPCC 2007). Due to these warnings, it is important to understand the causes of conflict and cooperation over international rivers. To contribute to this research effort, we consider attempts at collaboration through the formation of river treaties. Contrary to the predominant trend toward multilateral cooperation in other issue areas (Denemark and Hoffmann 2008), states sharing multilateral rivers have typically opted to reach bilateral agreements instead of multilateral agreements. To appreciate the need to account for this empirical puzzle, which appears to be similar to the general approach states have selected to govern environmental issues (Mitchell 2003), it is necessary to examine the consequences of uncoordinated governance of international river basins.

Fragmented governance contradicts the advice of hydrologists, environmentalists, and engineers who argue that the optimal and sustainable approach to manage an international river is to treat it as an integral unit that respects the ecological interdependence within the ecosystem (Global Water Partnership 2000). For this integrated water resources management approach to provide riparians with a collective good and permit the internalization of externalities, all basin states need to jointly manage the river in an ecologically sustainable manner that respects the interdependence between different users. Consider the need to share a basin with insufficient water, such as the multilateral Ganges River. Since 1972, India and Bangladesh have negotiated several agreements and memorandums in an attempt to share the dry-season flow. Storage facilities in upstream Nepal could be constructed to collect monsoon water that can be released during the dry season to augment the river's flow and dilute its highly polluted water. The riparians' failure to coordinate their development of the river through a multilateral effort has minimized the gains from cooperation, contributed to inefficient resource use, and resulted in environmental degradation of the basin (Hossain and Katiyar 2006).

Excluding riparian states from an accord that can affect the quality and quantity of water flowing in a river is likely to challenge the implementation, compliance, and long-term sustainability of any treaty. The 1994 Israeli-Jordanian Peace Treaty, which covered the Jordan River but excluded the Syrians, Lebanese, and Palestinians, is an example. Increased consumption of the Yarmouk tributary by upstream Syria has meant less water for downstream Israel and Jordan to comply with their treaty's fixed allocation commitments, which contributed to an environment of unstable cooperation (Delli Priscoli and Wolf 2009). Similar challenges are likely to plague the otherwise resilient Indus Waters Treaty. Signed between India and Pakistan in 1960, the treaty failed to consider the needs of the upstream riparians, China and Afghanistan. Yet, China is expected to increase its consumption of the Indus River, which can influence commitments in the Indus Waters Treaty (Salman 2008).

An alternative perspective posits that bilateral treaties may enhance cooperation in multilateral settings if these treaties are complementary to the broader regime. In an analysis of the nuclear proliferation regime, Verdier (2008) develops a formal model that treats multilateral and bilateral diplomacy as complements rather than substitutes. In the context of river negotiations, this model would imply that bilateral treaties might be used to supplement multilateral agreements if the riparians face high costs for compliance. This is more likely to occur when multiple riparians depend extensively on the resources the river provides. An example is the La Plata River, where the five riparians reached a multilateral accord in 1969 that permitted them to reach additional bilateral and

multilateral agreements to further the river's development (Gilman, Pochat, and Dinar 2008).

Riparians might settle in the short run for more limited bilateral agreements if the chances for a multilateral settlement are grim or not in their interest at the time. Botswana and South Africa reached a series of bilateral agreements regarding the Upper Limpopo Basin decades before the signing of the multilateral accord that established the Limpopo River Commission (Mohamed 2003:221–223). Similarly, the bilateral accords governing the Jordan River might have been necessary because the overall Arab-Israeli political dispute minimized the prospects of reaching multilateral accords (Just and Netanyahu 1998).

Existing Accounts of the Formation of River Treaties

The existing qualitative literature on managing international rivers tends to use either interest or power-based arguments to account for fragmented cooperation. Drawing on coalition theory, Just and Netanyahu (1998) propose that bilateral agreements are more common because of the moral hazard problems, fear of free-riding, and inefficiencies associated with multilateral negotiations. Others suggest that negotiators embrace bilateral treaties because they permit states to focus on and accommodate individual hydrological needs (Salman and Uprety 2002; Waterbury 2002). In multilateral negotiations, states with less interest in cooperation can increase the obstacles negotiators face and decrease the possibilities of reaching an accord (Swain 2002; Waterbury 2002). Consider the Nile River, where bilateral cooperation has been achieved more readily than multilateral cooperation because some riparians—Uganda, Egypt, Sudan, and Ethiopia—have an interest in reaching an accord, while others—Kenya, Tanzania, Burundi, and Rwanda—are less interested (Waterbury 2002). Consequently, the complexities in multilateral negotiations due to the varied interests among riparians often push in the direction of bilateral agreements.

Using power-based arguments, some have suggested that a treaty is likely to surface only when the powerful riparian has an interest in imposing it (Lowi 1993; Zeitoun and Warner 2006). Drawing on hegemonic stability theory, some propose that the powerful riparian prefers to negotiate and sign bilateral instead of multilateral treaties (Lowi 1993; Lautze and Giordano 2005; Hensel, Mitchell, and Sowers 2006). This preference exists because bilateral negotiations can maximize the powerful riparian's ability to secure its own needs and prevent the formation of coalitions that could increase the power of otherwise weaker riparians (Salman and Uprety 2002). Along the Ganges River, the powerful riparian, India, has dictated the signing of bilateral agreements, which permitted it to secure its interests and prevent coalitions between Nepal and Bangladesh (Crow and Singh 2000).

This insight also suggests that the location of the powerful riparian is a predictor of whether a treaty is reached (Lowi 1993). An upstream hegemon is less interested in reaching a treaty because an agreement might constrain its unilateral development of the river. Along the Euphrates and Tigris Rivers, upstream Turkey, the powerful riparian, has unilaterally developed the rivers and it has exported all positive and negative externalities to its downstream neighbors (Lowi 1993). In the case of a downstream hegemon, it is expected to dictate a treaty to its upstream neighbors to secure its needs. Egypt, the downstream hegemon along the Nile River, succeeded in negotiating a treaty with its weaker upstream neighbor that guarantees its own interests (Lowi 1993). The 1959 Agreement between the Republic of the Sudan and the United Arab Republic for the Full Utilization of the Nile Waters provided Egypt with 75% and upstream Sudan with 25% of the river's flow at Aswan, while the remaining upstream riparians received no water allocations (Waterbury 2002). Although

power-based arguments suggest that relative power is important, they cannot tell us whether the location of a hegemon has similar or different effects on cooperation in bilateral and multilateral basins.

The few existing empirical studies examining treaty formation tend to neglect the cooperation context. Espey and Towfique (2004), for example, focus on bilateral river treaties and use the basin dyad as their unit of analysis. They conclude that the significance of a basin to a state, economic interdependence, similarities in religion, and the number of states in the basin contribute to treaty formation (Espey and Towfique 2004). Their study excludes an examination of multilateral treaties and fails to consider the time-varying effects of the covariates.

Song and Whittington (2004) analyze treaty formation in bilateral and multilateral rivers. They discover that, "Adjacent upstream/downstream or side-by-side country pairs were less likely than country pairs with other spatial relations to have treaties" (Song and Whittington 2004:11). They find that states within the "Western civilization" are more likely to sign a river treaty, while riparians that are relatively equal in terms of economic and political power are less likely to cooperate. However, their dependent variable is the presence or absence of a treaty and not the type of treaty, which prevents them from accounting for fragmented cooperation.

Through an analysis of all river treaties that cover quantity and quality issues, Tir and Ackerman (2009) find that economic interdependence, joint democracies, water shortage, and preponderance of power all have a positive impact on treaty formation. This research design improves upon existing studies by expanding the basin dyad data to an annual format, which allows the covariates to have time-varying effects. However, this analysis does not consider the possibility that different forces influence the formation of bilateral versus multilateral treaties.

Treaty Formation in Bilateral and Multilateral Basins

The studies reviewed previously identify a rich set of economic, political, and geographical variables that influence treaty formation. Yet, we believe that the negotiation context is important, with bilateral cooperation in bilateral basins being different from cooperation in multilateral basins. Combining insights from neoliberal and neorealist international relations theory and the literature on international river management, we argue that the formation of various types of river treaties is a by-product of state interest, transaction costs, and the distribution of power.

State Interest

Negotiations can be long, arduous, and expensive for states. Consequently, it can be assumed that states need some interest in negotiating and reaching an agreement if they are willing to expend the financial resources. In the case of international rivers, interest derives from the extent to which riparians are currently dependent on an international river to meet their domestic freshwater needs or to the extent to which they expect to become dependent in the near future. States require a regular supply of freshwater to meet their irrigation, municipal, and industrial needs and operate their dams to generate hydropower. Of these requirements, the greatest consumers are farmers engaged in irrigation. On average, the agricultural sector consumes about 70% of a state's domestic water budget (Bruins 2000). This substantial consumption is justified because states tend to associate meeting domestic food needs with national security (Wolf 1995).

Riparians relying on their international river to meet domestic freshwater needs confront an interdependent and vulnerable relationship, which arises

because a river functions as an interdependent unit, and any changes within this system can have an impact on the entire basin (Zawahri 2008a). These relationships can challenge riparians' ability to meet their food and energy needs, respond effectively to floods and droughts, or allocate their domestic water budget. Unless a state is able to control the entire river, it faces a potentially difficult long-term relationship with its riparian neighbors because it cannot meet its domestic freshwater needs without communicating with its neighbors. In this situation, treaties can provide benefits to riparian states because they can standardize their expectations in the management of a shared river by establishing property rights (Benvenisti 1996; Waterbury 2002). Agreements also enable states to codify their responsibilities in developing the shared river (McCaffrey 2003).

Yet, a treaty will not automatically shift riparians from conflict to harmony (Zawahri 2008b). On the contrary, life after treaties can contain substantial challenges because management of shared rivers can involve continuous negotiations over such things as the construction and operation of dams along the river. In spite of the challenges of implementing a treaty and sustaining future cooperation under interdependent conditions, the presence of agreements lends some amount of predictability to states' interactions and enables them to draw on institutionalized mechanisms to manage disputes (Wolf, Yoffe, and Giordano 2003; Hensel, Mitchell, and Sowers 2006). Consequently, the more dependent riparians' states are on an international river, the more interest they have in reaching an agreement to secure their future access to the resource.

Hypothesis 1 (State Interest): *As states' dependence on a river increases, the formation of bilateral and multilateral river treaties becomes more likely.*

Transaction Costs

As states negotiate, they incur transaction costs, which arise as they collect information on the preferences of others, bargain, draft agreements, and enforce treaty commitments (Williamson 1985). The higher the transaction costs, the less likely that states will make the investment to negotiate and sign an accord. Due to the collective action problem confronting riparians as they attempt to collaborate, the number of interacting states is likely to affect both the negotiation and enforcement of treaties. In bilateral negotiations, states can easily assess the preferences of others and improve the chance of securing their individual interests. However, attempts to cooperation in *N*-player Prisoner's Dilemma games are likely to be plagued by difficulties (Olson 1965). Under these conditions, negotiations are likely to be complex and long because the diversity of interest makes it difficult to accommodate each state's individual needs and solicit concessions (Martin 1992). The increase in the cost of collecting information on the preferences of other states decreases the chances of reaching multilateral agreements (Oye 1985; Conybeare 1986).

Sustaining future cooperation with multilateral agreements is complicated because of the "sanctioning problem." In bilateral agreements, states can identify and manage the incentives to cheat by directly threatening to punish defection (Odell 2000). As the number of collaborating states increases, it becomes difficult to identify and punish defectors, which raises the potential for free-riding and the collapse of cooperation (Axelrod and Keohane 1985). If during the negotiation phase, states anticipate a strong compliance problem, they are less likely to embrace multilateral cooperation and more likely to select bilateral collaboration (Verdier 2008).

Yet, states still manage to reach multilateral agreements and they do find means to overcome these obstacles (Keohane 1990). Some have suggested that

multilateral cooperation is possible when a hegemon is willing to pay the sunk cost of negotiating an accord and sanctioning defectors (Martin 1992; Ikenberry 2001). Due to economies of scale, states might also prefer multilateral negotiations if the cost of negotiating many separate bilateral contracts is high or if states can achieve more in a multilateral accord than a series of bilateral agreements (Pahre 1994). Building on this insight, we argue that transaction costs are expected to be higher in multilateral basins than in bilateral basins. We focus on five factors that can decrease the transaction costs of multilateral negotiations: (i) economic interdependence, (ii) similar domestic legal systems, (iii) regime type, (iv) membership in intergovernmental organizations (IGOs), and (v) membership in environmental international non-governmental organizations (INGOs). We also control for the number of negotiating states and the geographical proximity of negotiating states.

Economic Interdependence

Building on the positive empirical relationship between trade interdependence and interstate cooperation, some have argued that greater economic exchanges can contribute to increased interactions between states (McMillan 1997). These increased interactions can lower the transaction costs of reaching agreements in other issue areas by facilitating the use of issue linkages and side-payments (Gartzke, Li, and Boehmer 2001). Economic interdependence can also build an environment of trustworthiness, which is expected to encourage states to foster cooperative relations over the management of other issue areas, such as international rivers. In fact, empirical analysis shows that economically interdependent states are more likely to reach agreements over their international rivers (Espey and Towfique 2004; Tir and Ackerman 2009). Strong trade ties can also “provide effective enforcement of agreements” (Espey and Towfique 2004:2). Due to improvements in states’ abilities to communicate with one another and demonstrate resolve when they are economically interdependent, overcoming the sanctioning problem in multilateral cooperation should be easier.

Similarity of Domestic Legal Systems

Since treaties are legal contracts between states that acquire the force of international law, states draw on the ideas inherent within their domestic legal traditions when they negotiate with other states (Powell and Mitchell 2007). States with different legal systems spend more time negotiating the content and design of treaties, which should increase the transaction costs of reaching an agreement. States with similar legal systems, such as two common law states, are less likely to confront such competition, which should decrease their transaction costs (Powell 2006; Mitchell and Powell 2009).

To appreciate the variance in legal transaction costs, we focus on distinctions between the major legal traditions: civil law, common law, and Islamic law (Badr 1978). Due to the difference in their legal philosophies and history, contracts from these three legal systems differ in their detail, length, and general principle (Powell and Mitchell 2007). Originating from the Roman Empire, civil law contracts tend to be relatively short and contain a small number of reservations. This stems from the prevalence of the *bona fides* or good faith principle in civil law, which reduces the need for lengthy contracts to specify the terms of contractual obligation (Mitchell and Powell 2009). Under common law, which began in the Norman conquest of Great Britain, contracts tend to be lengthy and highly inclusive, because there is less codified law that incorporates overarching general principles. Contracts under Islamic law are moderately detailed and lengthy, owing to the strength of the *pacta sunt servanda* principle in Islamic law, which

encourages the faithful to uphold their contracts (Rayner 1991). Since negotiators rely on their domestic legal systems as they design treaties, we expect states with similar domestic legal traditions to be more likely to strike accords over their international rivers than states with different legal systems because of the reduced transaction costs.

Regime Type

Democratic peace theory asserts that democratic governments behave differently toward one another than they do toward authoritarian regimes (Russett and Oneal 2001). We can anticipate that the transaction costs of negotiating and enforcing agreements will be lower when the interacting states are constitutional democracies, as opposed to other government types such as authoritarian or theocratic states (Lipson 2003). Due to the transparency of their domestic institutions, audience costs confronting leaders, the continuity of governance, and a constitutional structure, democratic states have a contractual advantage in negotiating treaties with other democracies (Lipson 2003). When states with shared democratic norms are negotiating, there appears to be an increase in trust between them, as well as an increase in the willingness to compromise and fulfill contractual commitments (Dixon 1994; Lipson 2003). Democratic states also tend to cooperate more with one another on a wider range of issue areas than they do with nondemocratic states (Mansfield, Milner, and Rosendorff 2000). We therefore expect democratic riparians to be more likely to reach treaties to manage their shared river because of the decrease in the transaction costs of negotiating and enforcing commitments. This expectation meshes with recent findings that democratic states are more likely to sign and ratify multilateral environmental agreements than nondemocratic states (Neumayer 2002).

Membership in IGOs and INGOs

Joint membership in IGOs and INGOs can also decrease the transaction costs of negotiating a treaty and assist in its enforcement. IGOs enable members to benefit from the network of links that they provide, which increase the opportunities for states to interact, build trust, and secure access to accurate information. IGOs can also assist states in structuring the negotiation agenda, and they can introduce policy proposals or suggest trade-offs to overcome deadlocks (Abbott and Snidal 1998). The World Polity theoretical framework posits that states that are highly interconnected in the world society through IGO memberships are exposed to the transmission of international norms regarding environmental protection. These linkages to the world society raise the likelihood that states will embrace domestic environmental protection policies and ratify international environmental treaties (Frank 1999).

These organizations can also provide channels for direct and indirect communication between states (Keohane 1984). Third parties, such as other member states or the IGO itself, can work through the organization to mediate disputes between states, which can facilitate the negotiations of treaties, assist to address fears of non-compliance with accords, or help resolve disputes (Mitchell and Hensel 2007; Dorussen and Ward 2008). Conflict resolution assistance that is available to IGO members should decrease the transaction costs of negotiating and sustaining multilateral treaties.

Drawing on their various channels of influence, INGOs can also assist to lower the transaction costs of negotiating and complying with treaties. Using their asymmetric specialized knowledge acquired from interaction at the sub-national and transnational levels, INGOs can sway states' interests at the negotiation tables toward cooperation (Princen, Finger, and Manno 1994). INGOs

can also disseminate their technical knowledge to the mass media, which can indirectly pressure governments to succeed in interstate negotiations. Another channel of influence for INGOs is to lobby governments directly and introduce policy options to address transboundary environmental issues. These channels enable INGOs to minimize states' transaction costs of policy research and negotiations (Raustiala 1997). The more integrated a state is in the world society through membership in environmental INGOs, the more likely it is to ratify international environmental treaties (Frank 1999). Once agreements are reached, INGOs become watchdogs over states, industries, and other domestic actors. This function can assist in the treaty's implementation and compliance (Princen, Finger, and Manno 1994). INGO's ability to provide independent assessments of states' compliance with accords helps to minimize the sanctioning problems and cut the transaction costs of maintaining cooperation in multilateral settings (Raustiala 1997).

With the decrease in transaction costs of negotiations that are brought about by similarities in legal systems, membership in IGOs and INGOs, jointly democratic governments, and economic interdependence, states are able to negotiate river treaties more successfully and overcome the anticipated sanctioning problem. However, we expect the effect of transaction costs to loom largest in the multilateral negotiation context and to exhibit weaker influences on bilateral bargaining. This is because transaction costs are amplified as the number of negotiating parties increases, as the set of feasible bargains that will please all states is reduced. As the number of negotiating states in a multilateral basin increases, states should find it more difficult to successfully negotiate a treaty, especially if the other factors (legal systems, democracy, economic interdependence, and IGO/INGO membership) raise the negotiation transaction costs further. In short, while these factors should influence all negotiations, they should show the greatest effect on multilateral negotiations.

Hypothesis 2 (*Transaction Costs*): *As transaction costs increase, states are less likely to reach river treaties, especially in multilateral basins.*

Distribution of Power

Neorealists paint a picture of a competitive anarchic world in which self-interested states are in a constant struggle to survive (Waltz 1979). Preoccupation with relative gains and fear of cheating minimize the prospects for long-term cooperation in this dangerous world. Yet, durable cooperation can surface when a hegemon is willing to pay the sunk cost of establishing, policing, and maintaining cooperative arrangements (Kindleberger 1973). Transferring the logic of hegemonic stability theory, which focuses on superpowers, to the relative distribution of power within a river basin requires some modification. While superpowers are less likely to focus on relative gains when cooperating with subordinate states, because any relative gain is not likely to upset the large gap in the distribution of capabilities (Martin 1992), powerful riparians such as India and China are expected to be more sensitive to relative gains because of the possibility that any gain can upset the existing distribution of capabilities. Consequently, we expect powerful riparians in multilateral basins to prefer bilateral treaties because these agreements allow them to impose a "divide and conquer" policy and secure substantial relative gains (Crow and Singh 2000). Thus, the presence of a regional hegemon in a multilateral basin is more likely to contribute to bilateral accords and less likely to facilitate the formation of a multilateral treaty.

As for the location of the hegemon within the multilateral basin, a downstream hegemon is likely to impose a bilateral accord on its upstream neighbor

to secure its future access to the resource. An upstream hegemon is expected to preserve its autonomy in developing the river and exporting externalities downstream. The upstream hegemon can accomplish these objectives best when it is unconstrained by treaty commitments, and therefore, it is less likely to reach a bilateral accord with its downstream neighbor (Lowi 1993).

Neorealism concedes that peace can arise when there is a balance of power between states (Gilpin 1996). Drawing on this point, it can be argued that a balance of power configuration within a multilateral basin is more advantageous to the formation of multilateral treaties. Negotiations between riparians with power parity can contribute to multilateral treaty formation because states are less likely to perceive themselves as being coerced or exploited by a hegemon. Moreover, under conditions of power parity, riparians are more likely to secure their interest in an agreement. Concerns with relative gains decrease substantially as the number of negotiating states rises, which increases the prospects for multilateral cooperation (Grieco, Powell, and Snidal 1993).

Neorealist expectations about the impact of power on cooperation can also help us anticipate the prospects of cooperation within bilateral basins. Similar to the expectations in a multilateral basin, the distribution of power is also likely to have an impact on reaching a treaty in a bilateral basin. An upstream hegemon is less likely to contribute to treaty formation in a bilateral basin, while a downstream hegemon is more likely to produce an accord (Lowi 1993).

Our argument refines the theoretical perspective of Tir and Ackerman (2009). They posit that power asymmetries have a positive influence on treaty formation. We argue that the relationship between power asymmetry and treaty formation depends on the number of states interacting in the basin, with the Tir and Ackerman posited relationship being strongest in the bilateral basin and bilateral negotiations context.

Hypothesis 3 (*Distribution of Power*): *Power asymmetries are more likely to produce bilateral river treaties in bilateral and multilateral basins, especially when the hegemon is located downstream, while power parity should increase the chances for multilateral agreements in multilateral basins.*

We expect river treaties to form in bilateral basins when there is interest among the riparians, an asymmetry in power within the basin, and a downstream hegemon. A bilateral treaty along a multilateral river requires interest among the riparians, lower transaction costs, and a downstream hegemon. Multilateral treaties require interest, lower transaction costs, and power parity between the riparians.

Research Design

To evaluate our theory, we construct a dyad-year river data set. Our list of river dyads is taken from PRIO's Shared River Basin GIS and Database (Owen, Furlong, and Gleditsch 2004). This data set has one record for each river dyad, or each pair of states that share membership in a river as defined by the International River Basin Registry (Wolf, Natharius, Danielson, Ward, and Pender 1999), the Digital Chart of the World rivers layer (DCW 1993), and the Historical Country Boundaries GIS (O'Loughlin, Ward, Lofdahl, Cohen, Brown, Reilly, Gleditsch, and Shin 1998). We expand these data to create one dyadic river case for each year of contiguity. This generates a total of 38,609 basin dyad-year observations from 1816 to 2007.

To capture our key dependent variable (treaty formation), we code whether a river treaty was reached in each basin dyad-year (1) or not (0) and note whether the treaty was bilateral or multilateral. The treaty data come from the

TABLE 1. Descriptive Statistics

<i>Variable</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>
Dependent variables					
Bilateral treaty	38,355	0.0056	0.0744	0	1
Multilateral treaty	38,355	0.0076	0.0871	0	1
State interest					
% Lowest area in basin	37,334	16.7320	16.7303	0.03	94.44
Lowest water dependence	38,130	12.0605	17.3829	0	94.23
Lowest avg. precipitation	38,096	880.168	575.755	51	2722
Transaction costs					
Lowest polity score	35,245	-2.6254	6.7240	-10	10
Same legal system	38,355	0.4902	0.4999	0	1
Contiguity	38,355	0.8636	0.3432	0	1
Number of states in basin	38,355	5.7136	4.5168	2	17
Minimum NGO	19,546	1.2630	2.3732	0	16
Minimum INGO	36,657	3.2360	2.8290	0	13
Trade dependence	17,070	5.7261	30.592	0.0002	1059.4
Distribution of power					
Upstream state CINC	34,779	0.0208	0.0456	1.14e-06	0.3839
Downstream state CINC	34,848	0.0208	0.0480	.00001	0.3839

Transboundary Freshwater Dispute Database,² which records 404 international freshwater-related agreements from 1820 to 2002.³ To capture the overall cooperation environment, we code whether the river is bilateral or multilateral. There are a total of 507 dyadic treaties in our data set; 214 are bilateral (42%), while 293 (58%) are multilateral. Among the bilateral treaties, 71 (33%) were signed on bilateral basins, while the remaining 143 (67%) treaties were signed in the context of a multilateral basin.⁴ At the treaty level of analysis, there are 54 multilateral agreements in our data set. Bilateral treaties are twice as common in the multilateral context compared with the bilateral river context.

Our independent variables capture three core theoretical concepts: state interest, transaction costs, and distribution of power. We use several indicator variables for each of these concepts. Descriptive statistics for all variables are provided in Table 1.

We use several proxy measures to assess the extent to which the less dependent state in a dyad is dependent on external sources for freshwater, which allows us to capture the scope of the dyad's mutual dependence. The first measure is the percentage of a state's area that resides in the basin, as recorded by the International River Basin Registry (Wolf et al. 1999). This measure stems from an assumption that the larger the percentage of the basin residing inside a given state, the more likely the state is to control a larger share of the basin and the less dependent it is on other states in the basin. We utilize a weakest link measure, which records the lowest value in the dyad for this variable. The mean for this variable is 16.73%, with a minimum of 0.03% (Russia, Kura-Araks River) and a maximum of 94.44% (Italy, Po River).

A second proxy measure for state interest denotes the extent to which a state is dependent on external sources of freshwater. These data are taken from the

² <<http://www.transboundarywaters.orst.edu/projects/internationalDB.html>>.

³ We thank Marit Brochmann for sharing a dyadic version of this database (Brochmann 2006).

⁴ There are 895 dyadic river treaty observations, but we are able to merge only 507 treaties due to missing basin dyads in the PRIO database. Among the 388 treaties not merged into our data set, 151 (39%) are bilateral and 237 (61%) are multilateral; of bilateral agreements, 69 (46%) were formed on bilateral basins, while 82 (54%) were formed on multilateral basins.

Food and Agriculture Organization (FAO) of the United Nations AQUASTAT Database.⁵ The FAO water dependence measure allows us to capture the percentage of a state's domestic water needs that originate outside of its borders.⁶ The higher this percentage, the more dependent a state is on external sources for water, while the lower this figure, the more a state is able to satisfy its domestic water demands internally. Using the weakest link principle, we code the lowest water dependence level in the dyad. The mean water dependence level in our data set is 12%, with a minimum of 0% (Norway) and a maximum of 94.23% (Hungary).

The final proxy for state interest is a measure of average precipitation rates, which permits us to examine a state's aridity. This measure is taken from the FAO's AQUASTAT Database and records the average water precipitation in depth (mm/year). We employ the weakest link principle by recording the lowest value of average precipitation in the dyad. This variable has a mean of 880.2 mm of rainfall per year, with a minimum of 51 mm/year (Democratic Republic of the Congo) and a maximum of 2722 mm/year (Malaysia).

Our next few indicators capture states' transaction costs. The first measure captures the lowest Polity IV democracy minus autocracy score in the dyad (Jagers and Gurr 1995).⁷ This variable ranges from -10 (most autocratic) to +10 (most democratic), with a mean value of -2.6 in our data set. The democracy and autocracy scales are calculated on the basis of several indicators, including the competitiveness of political participation, the regulation of political participation, the competitiveness and openness of executive recruitment, and constraints on the chief executive. As this regime score value increases, transaction costs for negotiation should diminish because of the contractual efficiencies experienced by democratic dyads.

The second indicator captures the similarity of domestic legal traditions between the states in the dyad. These data are taken from Powell and Mitchell (2007), where each state is assigned a domestic legal tradition of civil law, common law, Islamic law, or mixed law.⁸ A dyad is considered to have similar legal systems if both states have the same type of legal system (civil-civil, common-common, Islamic-Islamic). In our data set, 49% of all dyads involve states with the same domestic legal tradition.

The next two indicators of transaction costs code the number of states' memberships in IGOs and INGOs, both of which are predicted to lower the transaction costs in multilateral negotiations. For INGO memberships, we utilize a measure of environmental INGOs compiled by David John Frank.⁹ This is based on a random sample of 25 INGOs in the *Union of International Association Yearbook* for the years 1987-1988 and 2007-2008. Only organizations that focus on environmental protection are included. Once all relevant organizations are ordered chronologically, every fifth INGO is selected, and membership data are constructed at the country level. This limits our temporal domain to the 1960-2005 period, which reduces the total number of cases for analysis in half; thus, we include this variable in a separate set of analyses (Table 3). We employ a weakest link measure, which captures the smallest number of INGO environmental memberships for both states in a dyad; the mean number is 1.26, with a range of zero to 16.

We also include a measure of IGO memberships, limiting our focus to organizations that actively promote pacific dispute settlement in their charters. IGOs

⁵ <<http://www.fao.org/nr/water/aquastat/dbase/index.stm>>.

⁶ This indicator expresses the part of the total renewable water resources originating outside the country.

⁷ <<http://www.systemicpeace.org/polity/polity4.htm>>.

⁸ In mixed law states, more than one legal tradition is present.

⁹ We thank Professor Frank for sharing this data. <<https://webfiles.uci.edu/frankd/index.html>>.

can fulfill many different purposes; thus, an emphasis on peaceful conflict management helps to narrow the list to the most active IGOs in this substantive arena. This list is taken from the Multilateral Treaties of Pacific Settlement (MTOPS) data set, coded by Paul Hensel.¹⁰ We use a weakest link measure to capture the minimum number of pacific settlement IGO memberships in the dyad, which has a mean value of 3.24 in our data set, with a range from 0 to 13.

As noted earlier, we record the number of states in the basin. We include this measure in multilateral basin analyses only because there is no variance for the measure in the bilateral basin context. This ranges from 3 to 17. We also include a measure of direct land-based contiguity from the PRIO database, as it is more likely that contiguous states will have more opportunities for river-based cooperation. Eighty-six percentage of river-basin dyads share a direct land border.

We estimate some models including the level of economic interdependence between the riparian states, which should reduce transaction costs for reaching a multilateral agreement. We utilize a measure of trade dependence from Gleditsch's (2002) trade data set, which is calculated as follows:

$$\text{Trade Dependence} = \frac{(A's \text{ imports \& exports to B}) / A's \text{ GDP}}{(B's \text{ imports \& exports to A}) / B's \text{ GDP}}$$

With a mean of 5.68, this measure of trade dependence varies from 0.0002 to 1059.4. Unfortunately, we lose over 50% of the total basin dyad-year cases when we include trade dependence in the empirical models, which renders an already rare event (treaty formation) even rarer. We report results with (Table 4) and without (Table 2) the trade variable included.¹¹ Additional models employ the GDP per capita measure from the Fearon and Laitin (2003) data set.

To capture the distribution of power, we record the CINC capabilities ratio for the upstream and downstream state in each dyad. The CINC score is a national capabilities index developed by Singer, Bremer, and Stuckey (1972), which captures a state's proportion of total system capabilities in six areas: iron/steel production, energy production, urban population, total population, military expenditures, and military personnel. We obtained values for this variable from the Correlates of War (COW) Project's Web site.¹² The mean for both variables is 0.02 and ranges from (near) 0 to 0.38.¹³

All of the models capturing the onset of bilateral or multilateral river treaties are estimated as logit models with robust standard errors. To control for dependence across dyadic cases in the same basin, we also estimate models clustering the standard errors by river (Arceneaux and Nickerson 2009). These approaches help to account for the non-independence of cases across dyads in the same river, either over time or across dyads in multivariate situations. We describe the effects of these clustering strategies later in the text.

Empirical Analyses

Table 2 reports logit model estimates with robust standard errors for three cooperation contexts: (i) bilateral treaty on bilateral basins (model 1), (ii) bilateral treaty on multilateral basins (model 2), and (iii) multilateral treaty on multilateral basins (model 3). First, we find overall support for hypothesis 1 (*State Interest*). As reflected in Table 2, the variable for lowest water dependence is positive

¹⁰ <<http://www.paulhensel.org/icow.html#mtops>>.

¹¹ The correlations between the state interest variables and trade dependence are in the 0.4 range, which may explain the weakening of statistical significance for some of these measures (along with a sizable drop in sample size).

¹² <http://www.correlatesofwar.org/COW2%20Data/Capabilities/NMC_3.02.csv>.

¹³ In separate analyses (available from the authors), we also estimated the weaker state's CINC score in the dyad, which produces very similar results to those reported herein.

TABLE 2. River Treaty Signature on Bilateral and Multilateral River Basins

Variable	Model 1: bilateral	Model 2: bilateral	Model 3: multilateral
	treaties, bilateral basins	treaties, multilateral basins	treaties, multilateral basins
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
State interest			
% Lowest area in basin	-0.033 (0.009)**	0.007 (0.004)	-0.007 (0.005)
Lowest water dependence	0.044 (0.0103)**	0.015 (0.005)**	0.004 (0.003)
Lowest avg. precipitation	-0.001 (0.0002)**	-0.0007 (0.0002)**	-0.0006 (0.0002)**
Transaction costs			
Lowest polity score	0.01 (0.02)	0.05 (0.01)**	0.02 (0.01)*
Same legal system	0.29 (0.24)	1.33 (0.24)**	0.32 (0.13)*
Contiguity	-	1.91 (0.53)**	0.46 (0.17)**
Number of basin states	-	-0.05 (0.02)*	0.09 (0.01)**
Distribution of power			
Upstream state CINC	6.21 (1.09)**	4.18 (1.99)*	-7.70 (2.31)**
Downstream state CINC	-0.22 (1.73)	5.86 (1.97)**	-14.70 (4.70)**
Constant	-4.20 (0.38)**	-7.23 (0.62)**	-4.80 (0.21)**
	N = 12,186	N = 21,187	N = 21,187
	$\chi^2 = 74.23$ ($p < .001$)	$\chi^2 = 193.14$ ($p < .001$)	$\chi^2 = 190.77$ ($p < .001$)
	Pseudo- $R^2 = 0.07$	Pseudo- $R^2 = 0.09$	Pseudo- $R^2 = 0.05$

Entries are coefficients followed by robust standard errors; * $p < .05$, ** $p < .01$

and statistically significant in two of the three models. This shows that as states' dependence on a river increases, the likelihood of a bilateral treaty increases as well. Increasing dependence from its minimum to its maximum increases the chances for a bilateral treaty by 335% in the multilateral basin and by 5705% in the bilateral basin.¹⁴ We see a similar effect for average precipitation, which has the correct sign (negative) and achieves statistical significance in all three cooperation contexts. The most arid countries in the data set are 423–1659% more likely to sign treaties in comparison with the most water-abundant countries. The findings for percent area in basin are mixed across the three environments, reducing treaty formation only for bilateral treaties on bilateral basins. This fits with our expectation that as more of the basin's area resides inside a state, the country has less interest in a treaty. In Table 2, model 1, as the percentage of a state's area in the basin increases from its minimum to its maximum, the probability of bilateral treaty decreases by 1653%. In short, a dyad's high dependence on a river promotes more cooperation, a finding that has been reported in other research on freshwater (Wolf 1998). It is similar to work on contentious issues, where higher issue salience increases the likelihood of treaties (Hensel, Mitchell, Sowers, and Thyne 2008).

Second, we examine the findings for hypothesis 2 (*Transaction Costs*). Several variables proxy these costs: regime type, domestic legal system similarity, INGO membership, IGO membership, contiguity, and number of basin states. Contiguous, democratic dyads with similar legal systems and many INGO/IGO memberships should face lower transaction costs in bargaining than dyads comprised of autocratic and legally dissimilar states. These effects should be strongest in the multilateral basin. The empirical results in Table 2 are consistent with these predictions. Neither democracy nor legal system similarity is significant in the bilateral basin (model 1). However, both variables are positive and significant in the multilateral basin (models 2 and 3), showing that states with fewer transaction costs are better able to strike bilateral and multilateral accords. For bilateral

¹⁴ Substantive values are calculated using Clarify (King, Tomz, and Wittenberg 2000), setting all variables at their mean or mode. Given the rareness of the dependent variables, the predicted probabilities are relatively small. The probability of treaty signature increases from 0.0025 to 0.0642.

TABLE 3. River Treaty Signature, Adding non-governmental organizations (NGO) and intergovernmental organizations Measures (IGO)

<i>Variable</i>	<i>Model 1: bilateral treaties, bilateral basins</i> <i>Coefficient (SE)</i>	<i>Model 2: bilateral treaties, multilateral basins</i> <i>Coefficient (SE)</i>	<i>Model 3: multilateral treaties, multilateral basins</i> <i>Coefficient (SE)</i>
State interest			
% Lowest area in basin	-0.0178 (0.0106)	0.0105 (0.0058)	0.0018 (0.0060)
Lowest water dependence	0.0469 (0.0142)**	0.0138 (0.0053)**	0.0101 (0.0036)**
Lowest avg. precipitation	-0.0018 (0.0004)**	-0.0006 (0.0002)**	-0.0001 (0.0002)
Transaction costs			
Lowest polity score	0.03 (0.03)	0.07 (0.02)**	-0.01 (0.01)
Same legal system	0.60 (0.42)	0.92 (0.28)**	0.13 (0.17)
Contiguity	-	2.88 (1.02)**	0.45 (0.20)*
Number of basin states	-	-0.06 (0.03)	0.07 (0.02)**
Minimum NGO	-0.08 (0.07)	-0.16 (0.06)**	0.11 (0.04)**
Minimum INGO	0.26 (0.06)**	-0.07 (0.07)	0.02 (0.04)
Distribution of power			
Upstream state CINC	6.32 (2.74)*	1.29 (2.80)	-5.88 (2.29)**
Downstream state CINC	0.14 (3.80)	6.63 (2.11)**	-14.12 (4.93)**
Constant	-5.44 (0.75)**	-7.44 (1.14)**	-5.41 (0.29)**
	<i>N</i> = 4,983	<i>N</i> = 12,082	<i>N</i> = 12,082
	$\chi^2 = 52.17$ ($p < .001$)	$\chi^2 = 135.68$ ($p < .001$)	$\chi^2 = 199.74$ ($p < .001$)
	Pseudo- $R^2 = 0.12$	Pseudo- $R^2 = 0.10$	Pseudo- $R^2 = 0.04$

Entries are coefficients followed by robust standard errors; * $p < .05$, ** $p < .01$

treaties on multilateral basins (model 2), the most democratic dyads are 177% more likely to reach agreement, while dyads with similar legal backgrounds are 268% more likely to reach agreement. For multilateral treaties (model 3), the substantive effects are smaller; a 49% increase for the most democratic dyads compared with the least democratic dyads and a 37% increase for dyads with the same legal system. These results are different from Espey and Towfique (2004), as they found no significant effect for government similarity.¹⁵ Tir and Ackerman (2009) reported a positive effect for joint democracy on treaty formation, although our results indicate that these effects occur primarily in negotiations over multilateral basins.

We lose close to half of the observations for estimation when employing the environmental INGO measure, which is why we report the effects of INGOs and IGOs separately in Table 3. The two nonstate actors have different effects on treaty formation depending on the negotiation context. Table 3, model 1 shows that as the minimum number of pacific settlement IGO memberships in the dyad increases, states are significantly more likely to reach bilateral treaties on bilateral basins. As the IGO variable increases from its minimum (0) to its maximum (13), the probability of bilateral treaty formation increases by 2450%. This finding could reflect in part the presence of regional organizations, such as the Organization of American States and the European Union, who often assist members in reaching treaties. On the other hand, the IGO variable has no effect on treaty formation in the multilateral basin. Rather, environmental INGOs are important in this cooperation context, serving to significantly increase the chances for a multilateral treaty (Table 3, model 3). As the INGO variable increases from its minimum (0) to its maximum (16), the probability of a

¹⁵ This difference could exist because Espey and Towfique (2004) do not differentiate between bilateral treaties on bilateral and multilateral basins and they rely on The World Almanac to classify government types, while our Polity IV database uses a more sensitive scale.

multilateral agreement increases by 507%. We also find in Table 3, model 2 that the significant presence of INGOs serves to minimize the chances for fragmented governance of the river by reducing the likelihood for more limited, bilateral treaties.¹⁶

Our theoretical expectation for hypothesis 3 (*Distribution of Power*) is that power asymmetries are more likely to produce bilateral treaties, while power parity should increase the chances for multilateral agreements. This expectation is borne out in Table 2. Increases in the upstream state's CINC score result in significant increases in the formation of bilateral accords, while a reduction in the upstream state's power makes multilateral treaties more likely. The substantive effects are largest for model 1 (bilateral treaties, bilateral basins), as the most powerful upstream states on bilateral basins are 967% more likely to reach bilateral treaties than the weakest upstream states. In separate analyses (available from the authors), we also measured relative power as the percentage of the weaker state's CINC score in the dyad. We found similar results, namely that increases in the weaker side's strength (approaching parity) significantly reduce the chances for bilateral treaty, while enhancing the chances for multilateral cooperation. Tir and Ackerman (2009) show a positive effect for power asymmetry and treaty formation, although our results demonstrate again that these relationships are context dependent.

However, the positive and significant finding for upstream state power in Table 2 contradicts our expectations that an upstream hegemon prefers to develop the river without making treaty commitments. The possible explanation for this outcome is that the powerful upstream riparian might have an interest in a treaty due to the gains from cooperation. A treaty can permit the upstream hegemon to secure its freedom in developing the river, access the donor community to underwrite this development, and minimize the potential losses incurred from dependence on an international river.

In multilateral basins, the effect of the upstream state's CINC score on treaties is statistically significant, but substantively weaker for fragmented accords (Table 2; model 2, 504% increase). The effect of upstream power on multilateral agreements is much stronger, reducing the likelihood of an accord by 1169% as the upstream state's CINC score moves from its minimum to its maximum. The downstream state's capabilities have an effect only on multilateral basins, increasing the chances for bilateral agreements (model 2) and reducing the likelihood of multilateral agreements (model 3). The substantive effects are largest for multilateral treaties on multilateral basins, with the most powerful downstream states being 1007% more likely to reach bilateral accords in multilateral basins and 6123% less likely to reach multilateral accords in comparison with the weakest downstream states. The results for the state interest and transaction costs variables are fairly similar no matter which distribution of power indicator is selected. These findings are consistent with our expectation that a downstream hegemon is likely to contribute to the formation of bilateral treaties over multilateral basins.

We see in both Tables 2 and 3 that direct land-based contiguity increases the likelihood of river treaties being reached in multilateral basins. The number of riparians in the basin has the strongest effect in the multilateral treaty, multilateral basin context, which could simply reflect the increased number of dyadic observations for multilateral agreements.

¹⁶ The effects for the shared interest variables are similar when the INGO and IGO variables are added. Regime type and shared legal system have reduced effects in Table 3, Model 3, although this reflects in part the fact that democracies tend to join IGOs more frequently and welcome the participation of INGOs more readily. The bivariate correlation between regime type and INGOs is 0.55, while the correlation between regime type and IGOs is 0.25.

TABLE 4. River Treaty Signature, Adding Trade Dependence

Variable	Model 1: bilateral treaties, bilateral basins	Model 2: bilateral treaties, multilateral basins	Model 3: multilateral treaties, multilateral basins
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
State interest			
% Lowest area in basin	-0.0141 (0.0092)	0.0086 (0.0046)	-0.0089 (0.0058)
Lowest water dependence	0.0481 (0.0127)**	0.0218 (0.0050)**	0.0055 (0.0034)
Lowest avg. precipitation	-0.0014 (0.0003)**	-0.0005 (0.0002)*	-0.0005 (0.0001)**
Transaction costs			
Lowest polity score	0.05 (0.02)*	0.05 (0.01)**	0.02 (0.01)*
Same legal system	-0.41 (0.42)	1.39 (0.34)**	-0.12 (0.16)
Contiguity	-	1.93 (0.72)**	0.17 (0.21)
Number of basin states	-	-0.04 (0.03)	0.06 (0.01)**
Trade dependence	-0.13 (0.10)	-0.004 (0.007)	0.003 (0.001)**
Distribution of power			
Upstream state CINC	3.10 (1.76)	5.75 (2.33)*	-6.26 (2.82)*
Downstream state CINC	-2.17 (2.13)	10.19 (2.03)**	-11.16 (5.81)
Constant	-3.21 (0.56)**	-7.69 (0.84)**	-4.25 (0.26)**
	N = 5,891	N = 11,052	N = 11,052
	$\chi^2 = 37.05$ ($p < .001$)	$\chi^2 = 190.37$ ($p < .001$)	$\chi^2 = 91.92$ ($p < .001$)
	Pseudo- $R^2 = 0.08$	Pseudo- $R^2 = 0.10$	Pseudo- $R^2 = 0.03$

Entries are coefficients followed by robust standard errors; * $p < .05$, ** $p < .01$

Tir and Ackerman (2009) and Espey and Towfique (2004) report strong effects for economic interdependence as a force for river treaty cooperation. Table 4 replicates the analyses in Table 2, adding trade dependence as an additional measure of transaction costs. The results for state interest remain robust in this reduced set of cases. The dyadic regime score has the same effect as well, although the effect of legal system similarity is no longer significant for multilateral treaties (model 3). The effects for distribution of power are somewhat weaker in these models as well, as only upstream state CINC scores matter for multilateral agreements (negatively). Trade dependence has a statistically significant effect only for multilateral treaties on multilateral basins. Basins with a larger number of states who are more economically interdependent strike more multilateral accords; the dyads with the highest levels of trade dependence are 1479% more likely to reach multilateral agreements than pairs of states with very low trade. The trade dependence result is consistent with our discussion of lowered transaction costs. Yet, these results show that the empirical findings of previous studies are not generalizable to all river contexts; they have the strongest influence in multilateral basins.¹⁷

One limitation of our research design is the treatment of multilateral agreements as dyadic observations. Yet, a similar strategy is employed in many studies of interstate cooperation, including the analyses of military alliance formation (Lai and Reiter 2000), shared international organization memberships (Russett and Oneal 2001), and shared membership in preferential trade agreements (Mansfield and Reinhardt 2003). To consider the number of states involved in the broader agreement, we also estimated regression (and Poisson) models where the percentage (or number) of states in the basin that have reached agreement is the dependent variable. All four of these models are restricted to

¹⁷ We also controlled for the minimum GDP/capita in the dyad. Wealthier states are more likely to reach bilateral treaties in bilateral basins, although inclusion of this variable does not alter the findings for any other variables as reported in Table 2. GDP/capita has no effect in any models of cooperation in multilateral basins. Moreover, we found no discernable temporal trends in the type of treaty over time. (Results are available from authors.)

the multilateral treaty, multilateral basin context where we observe significant variation in the number of states involved in a given treaty. The effects for state interest are a bit weaker in these models, although the average precipitation measure is negative and statistically significant in all four models. Democracy does not have an effect on the number or percentage of states in agreement, although legal system similarity is positive and significant in three of the four models. Direct contiguity increases the number of states in agreement, while basins with a larger number of states produce agreements with a larger number of states. The results for the distribution of capabilities measures are similar to what we reported in earlier tables. Parity tends to lead to broader, multilateral agreements, while power asymmetries for upstream or downstream states make fragmented accords more likely.¹⁸

The logit model with robust standard errors does not directly control for correlations among the observations across space or time. We also estimated the models in Tables 2–4 by clustering the standard errors by river basin. The results for bilateral cooperation (in either river context) are robust to clustering the standard errors by basin. On the other hand, many of the transaction costs and state interest measures have weaker effects in the multilateral agreement, multilateral basin context when the clustering option is employed. This reflects, in part, similar regional patterns in rainfall and water dependence that are likely to connect various dyads in the same river. Regime type and legal systems are also similar between states in the same region; thus, it makes sense that these variables have weaker effects when the standard errors are clustered by basin.

Discussion

This study presents several theoretical implications to the international relations literature. Although the concept of transaction costs has been used pervasively in analyses of interstate cooperation and the role of institutions as facilitators of cooperation (Yarbrough and Yarbrough 1992), there is a paucity of quantitative examinations of its function (Lipson 2004). This lack of empirical analysis derives from an uncertainty about how to measure transaction costs (Katzenstein 1996). Some tend to draw on the economics literature to generate indices, but these proxies—frequency of transactions, their complexity, and asset specificity—are difficult to transfer to international relations (Lipson 2004). The other available proxies can only be observed *post hoc* or do not adequately represent international relations (Sherman and Solomon 2001). Our study attempts to quantify the impact of transaction costs on cooperation by considering the number of states interacting, the similarity in domestic legal systems, membership in IGOs and INGOs, regime type, and economic interdependence. Although the number of actors involved in the negotiations is used as a proxy to measure transaction costs (Weber 2000), the possibility that the aforementioned variables can also have an impact has been relatively neglected. Through quantitative analysis, our study has demonstrated that most of these indices do influence the transaction costs of multilateral negotiations. The benefit of these indices is that they permit us to avoid the *ad hoc* nature of existing proxies and they better reflect the international relations between states.

¹⁸ Some dyads may have signed prior agreements over their shared river, while others may be striking the first accord. We estimated several models controlling for prior agreements. In the bilateral basin, adding prior agreements reduces the significance of most variables, consistent with the overwhelming effects of lags in time series models (Achen 2000). Our results in the multilateral basin are a bit more robust, yet the measures for state interest have weaker effects when controlling for prior agreements. These results are available from the authors.

Contrary to the belief that a hegemon can contribute to the rise of multilateral cooperation (Martin 1992; Ikenberry 2001), our findings reveal that the presence of a hegemon within a multilateral river basin tends to contribute to bilateral treaties. Multilateral accords surface in basins with power parity. This finding contributes to several areas of study, such as international trade and alliance formation. According to neoliberal economics, global or multilateral free-trade agreements can promote national and global welfare. Contrary to this advice, states have tended to reach bilateral and regional preferential trading arrangements (PTAs) that provide member states with economic gains, while adversely affecting third parties and reducing global welfare. While a combination of factors can account for these fragmented attempts at cooperation in international trade, the distribution of power seems to have a significant impact (Mansfield and Milner 1999). A hegemon can establish a global free-trade bloc (Kindleberger 1973), but its decline or absence can contribute to the formation of bilateral or regional PTAs (Gilpin 1975). Mansfield and Milner (1999) argue that the exact link between the distribution of power and formation of PTAs remains underexamined. Powerful states may prefer the formation of PTAs with weaker states to create a dependent relationship and bolster their military capacity. Alternatively, a group of states can form PTAs to protect themselves from a third party (Mansfield and Milner 1999). Our research suggests that power is likely to be most important in bilateral PTAs, while it is likely to be diffused in multilateral PTAs. In other words, stronger states can seek to form bilateral PTAs with weaker states, while a parity of power is likely to contribute to either regional or multilateral PTAs.

Due to the problems plaguing collective action in a multilateral context, neo-realists have suggested that alliance formation and maintenance are much harder in a multilateral rather than a bilateral international system (Waltz 1979). Alliances in a multilateral system confront constant fear of entrapment and abandonment, which places commitments in doubt. In a bipolar system, superpowers can manage fears of entrapment, which makes alliances more stable (Snyder 1984). Our findings suggest that the problems confronting the formation of multilateral alliances in a multilateral system can be managed when alliance members possess the following features: there is interest in the formation of an alliance, parity in power among members, similar legal systems, joint democracies, high levels of INGO memberships, and economic interdependence. While existing studies identify several of these factors as being relevant for alliance formation (Lai and Reiter 2000), they do not consider the context within which security cooperation emerges. Our analyses also suggest that transaction costs variables should be less relevant for the formation for bilateral alliances relative to multilateral alliances. Future research can build on these findings to test the possibility that these factors can contribute to the formation of multilateral and bilateral alliances.

Conclusion

This study explains the prevalence of fragmented governance of multilateral basins, such as the Indus, Jordan, Euphrates, and Ganges rivers, where only a subset of all riparian states sign cooperative river treaties. To account for the puzzle of fragmented governance, we focus on river treaty formation in three distinct negotiation contexts: bilateral treaties on bilateral basins, bilateral treaties on multilateral basins, and multilateral agreements on multilateral basins. We argue that the variance in these types of treaties can be accounted for by state interest, transaction costs, and the distribution of power within the basin. The more riparians depend upon an international river, the more interest they have in arriving at an accord to stabilize their future expectation in developing the

river and minimizing the potential losses from uncoordinated development. Throughout the negotiation process, states are likely to incur transaction costs. The higher these costs, the less likely that states will expend the resources to reach an agreement. To measure transaction costs confronting riparians, the number of states negotiating, similarities in their legal system, jointly democratic institutions, membership in INGOs/IGOs contiguity, and trade interdependence were considered. The relative distribution of power was also considered in both bilateral and multilateral basins. The findings reveal that bilateral treaties on bilateral basins are more likely to occur when states have an interest in the river and there is an asymmetry of power. Transaction costs do not appear to influence the rise of bilateral treaties on bilateral basins, while a powerful upstream state contributes to treaty formation. Multilateral treaties are likely to arise when there is interest, power parity among riparians, and a decrease in transaction costs. Fragmented governance is more likely when there is interest, lower transaction costs, and a downstream hegemon capable of breaking up multilateral negotiations into bilateral ones. Except for state interest, the other factors that promote cooperation vary by context.

Implications from our findings for the literature on managing international river disputes include the need to appreciate the distribution of power within the basin and its effect on treaty formation. This point should be taken into consideration especially by third-party mediators as they employ carrots and sticks to facilitate negotiations. Another implication is the finding that dyadic dependence on an international river produces greater interest in a treaty. If less dependent riparian states are included in the negotiations, mediators might consider the use of issue linkages and side-payments to overcome the asymmetry in interests. Mediators can also use the knowledge generated about the influence of transaction costs on treaty negotiation. If riparian states confront differences in legal traditions or government types that would increase transaction costs, mediators need to be cognizant of these impediments in order to facilitate the negotiation process in a manner that can decrease the cost of negotiations. Environmental INGOs can also help to fill this gap and assist in the formation of multilateral accords.

Findings from this study introduce several research questions that we plan to consider in the future. First, we would like to examine the contents of bilateral versus multilateral accords to see whether one is shallower in terms of the requirements needed for cooperation. One possibility is that bilateral agreements may require more behavioral altering cooperation and are therefore deeper than multilateral agreements (Gilman, Pochat, and Dinar 2008). Some suggest that the by-product of multilateral negotiations might be “lowest-common-denominator agreements with little substantive content” due to the diversity of interests (Hopmann 1996:270). Related to this research question, we would like to examine the long-term sustainability or stability of multilateral versus bilateral accords governing multilateral basins. Some suggest that multilateral agreements are likely to be more stable in the long term (Crow and Singh 2000). Such an expectation would lead us to anticipate that fragmented governance may contribute to unstable cooperation as the excluded riparian states continue to develop the shared river. Finally, we plan to focus more attention on the issues at stake in river treaty negotiations, such as water quality, water quantity, and hydroelectric power. Some types of issues are more naturally negotiated in a more limited bilateral context, such as border issues, while other issues like economic development and joint management are more likely to be handled through multilateral negotiations. We hope to develop more explicit typologies of issue types to better understand how state interest, transaction costs, and the distribution of power influence the likelihood of distinct forms of cooperation over international rivers.

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